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USE OF CHAINING TO INCREASE COMPLEXITY OF ECHOICS IN CHILDREN WITH AUTISM

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Echoics are a critical target of language intervention for children with autism, because a well-established echoic repertoire on the part of the child allows the clinician to use vocal modeling as a flexible, low-effort prompting procedure during teaching. In this study, we implemented a chaining procedure to increase the complexity of echoics in 2 children with autism and 1 child with developmental delay. The procedure was effective for all 3 participants, and gains were maintained after treatment was withdrawn in most cases.

DESCRIPTORS: autism, chaining, echoics, vocal imitation

The echoic is a verbal operant in which the topography of the behavior has point-to-point correspondence and formal similarity with the antecedent verbal stimulus that controls it and for which the reinforcement is not specific to the topography of the behavior (Skinner, 1957). Echoics are also commonly referred to as *vocal imitation*. Once established, a generalized echoic repertoire (generalized vocal imitation) permits the speaker to imitate virtually any vocal model. This ability allows for low-effort vocal prompting for language acquisition. Because of the utility of the echoic repertoire, echoic training is generally considered to be an essential component of behavioral intervention for young children with autism (Sundberg & Michael, 2001).

Several procedures for establishing echoics have been reported in the research literature (Sautter & LeBlanc, 2006). One option is to begin by reinforcing all vocalizations and then to proceed with shaping imitation by providing a vocal model, reinforcing approximations, and training discrimination between vocal models of various sounds (Lovaas, Koegel, Simmons, & Long, 1973). One study, which taught children with autism novel echoic responses in combination with mastered ones, demonstrated that positive reinforcement alone can increase accuracy (Young, Krantz, McClannahan, & Poulson, 1994). When vocal imitation does not readily occur and cannot be reinforced directly, other procedures have been investigated. One study demonstrated the effectiveness of presenting rapid sequences of motor imitation immediately prior to the vocal model (Ross & Greer, 2003). Research has also demonstrated the effectiveness of a stimulus-stimulus pairing procedure, wherein vocal sounds are paired with reinforcers in a respondent manner (Sundberg, Michael, Partington, & Sundberg, 1995; Yoon & Bennett, 2000); however, the extent to which this procedure produces long-term maintenance is not clear and requires further investigation (Miguel, Carr, & Michael, 2002).

Although a significant amount of research has been done on how to establish basic echoics, little research has evaluated procedures for expanding the complexity of echoics in children with autism. For example, some children may echo simple auditory stimuli (e.g., phonemes) but may not be able to echo longer or more complex stimuli (e.g., words or phrases). One potential treatment procedure is to break longer auditory stimuli into smaller units and to teach echoics as chains. Little or no previous research has evaluated the effectiveness of this procedure.

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Therefore, the purpose of the current study was to evaluate the effectiveness of a chaining procedure for increasing the complexity of echoics in children with autism.

METHOD

Participants and Settings

All participants were clients of a community-based agency that provides comprehensive behavioral services to individuals with autism. All were receiving home-based behavioral intervention that addressed all deficit areas (e.g., language, socialization, play, self-help skills, problem behaviors). All procedures described in this study were implemented as a part of the children's regularly scheduled home-based therapy services, by the participants' regular therapists, in a one-to-one format. Danny was a 5-year-old boy with autism. He attended a public segregated special day class for 20 hr per week with a personal aide. He was able to mand with single-syllable utterances to have his basic needs met and could tact with single-syllabus utterances when prompted. Echoic chaining had never before been used. Donny was a 7-year-old boy with autism who had significantly delayed language. At the time of intervention, Donny could imitate approximations of about six sounds, but did not independently use vocal language. Instead, he used gestures to communicate. He attended a private regular education classroom with a personal aide for 1 hr per day. He had a small amount of exposure to echoic chaining prior to this study. Allen was a 3-year-old boy with a diagnosis of developmental delay who resided in foster care. He could emit a variety of mands and tacts, but only used single-syllable approximations (e.g., ''coo'' for ''cookie''). Echoic chaining had not been used previously.

Response Measurement and Interobserver Agreement

Three echoic behaviors were selected for inclusion for each child in the study. Particular echoics were selected by the participants' regular therapy teams, in accordance with participants' ongoing clinical priorities. Danny's targets were ''Victoria,'' ''Andrea,'' and ''Monday.'' Donny's three targets were ''ball,'' ''tub,'' and ''hop.'' Allen's targets were ''water,'' ''bottle,'' and ''I want.'' Data were collected on correct imitation of trials of the full echoic target within 5 s of the model and were summarized as percentage correct (calculated by dividing the number of trials in which the full vocal response was modeled and the correct response occurred by the total number of trials in which the full response was modeled, and this ratio was converted to a percentage). Interobserver agreement was assessed by having a second independent observer collect data during 27%, 46%, and 37% of sessions for Danny, Donny, and Allen, respectively. Interobserver agreement was calculated by dividing the number of trials in which the two observers scored exactly the same data by the total number of trials for which a second observer collected data, and this ratio was converted to a percentage. Mean interobserver agreement was 95% for Danny (range, 90% to 100%), 85% for Donny (range, 20% to 100%), and 98% for Allen (range, 60% to 100%).

Experimental Design and Sequence

A multiple baseline design across behaviors was used to demonstrate experimental control of the intervention in producing the initial acquisition of the targeted behaviors. In addition, treatment was withdrawn for each behavior after that behavior reached mastery criteria to assess maintenance after treatment had been discontinued. Sessions occurred one to three times per day, 1 to 4 days per week, depending on child and therapist availability.

Procedure

During each session throughout the study, the therapist presented five trials of the echoic being targeted in that session. The sequence of sessions among the three echoics was randomly

determined. During baseline, a trial began by the therapist presenting the full vocal model of the targeted echoic (e.g., ''say 'Monday'''). The therapist provided a putatively neutral consequence (saying ''okay''), contingent on correct responding, incorrect responding, or a lack of responding for 5 s. During the chaining condition, each target echoic was divided into two components (e.g., ''Monday'' was divided into ''mun'' and ''day''). No formal rule was used for how to divide one- or three-syllable echoics into two components. Instead, clinicians judged which option sounded the simplest and least awkward (e.g., ''ball'' was divided into ''b'' and ''all''). During each chaining session, the therapist presented one echoic in three sequential trials as rapidly as feasible (i.e., the therapist presented a trial immediately after the completion of reinforcement for the previous trial). On the first trial, the therapist modeled the first component (e.g., ''say 'mun'''). If the participant correctly imitated this component within 5 s, the therapist delivered reinforcement and immediately modeled the second component (e.g., ''say 'day'''). If the participant imitated the second component correctly, the therapist delivered reinforcement, modeled the entire target echoic (e.g., ''say 'Monday'''), and provided reinforcement for correct imitation. An incorrect response on any of the three trials resulted in a single repetition of that trial, after which the therapist resumed the sequence. The therapist repeated the sequence of three trials four more times for a total of 15 trials per session. Reinforcement consisted of the child's regularly programmed reinforcer (identified prior to each session via a brief multiple-stimulus preference assessment) and usually included such consequences as praise, tickles, and tokens (none of the participants earned edible reinforcers as a regular part of their therapy, so they were not used in this study). Reinforcement was never specific to the topography of the echoic (e.g., water was never delivered as a consequence for saying ''water''). Mastery was defined as correct imitation of the whole target echoic on at least four of the five trials of each session that contained the whole target echoic across three consecutive sessions. After the child mastered each echoic, the maintenance phase was initiated for that echoic, in which sessions were identical to the baseline phase.

RESULTS AND DISCUSSION

The results for all participants are depicted in Figure 1. Only data on trials of the full echoic response are depicted. Danny acquired all target echoics rapidly (i.e., five to nine sessions each). ''Victoria'' and ''Andrea'' were maintained successfully when treatment was withdrawn. Treatment was not withdrawn for ''Monday'' due to time constraints. Donny's acquisition of ''ball'' required 35 sessions before mastery criteria were met. Treatment withdrawal sessions were not conducted immediately after ''ball'' was mastered, and when they were, ''ball'' was not initially maintained. However, as Donny's second and third targets were taught and moved into the maintenance phase, his performance with the first target began to improve and subsequently was maintained at 100% correct. He acquired ''tub and ''hop'' more quickly (17 and 6 sessions to mastery, respectively), and these targets were maintained when treatment was withdrawn during the maintenance phase. Allen mastered all echoics rapidly (i.e., five to eight sessions). All targets were maintained during the maintenance phase, but ''bottle'' was variable.

The results of this study suggest that a chaining procedure can be effective for increasing the length of echoics in children with autism. Treatment produced efficient results, and maintenance occurred in most cases. These results contribute to the existing knowledge base on language interventions for children with autism by providing data on a treatment procedure for increasing the complexity of echoic utterances, a subject of little previous research. In addition, the current study was conducted as a regular part of everyday clinical

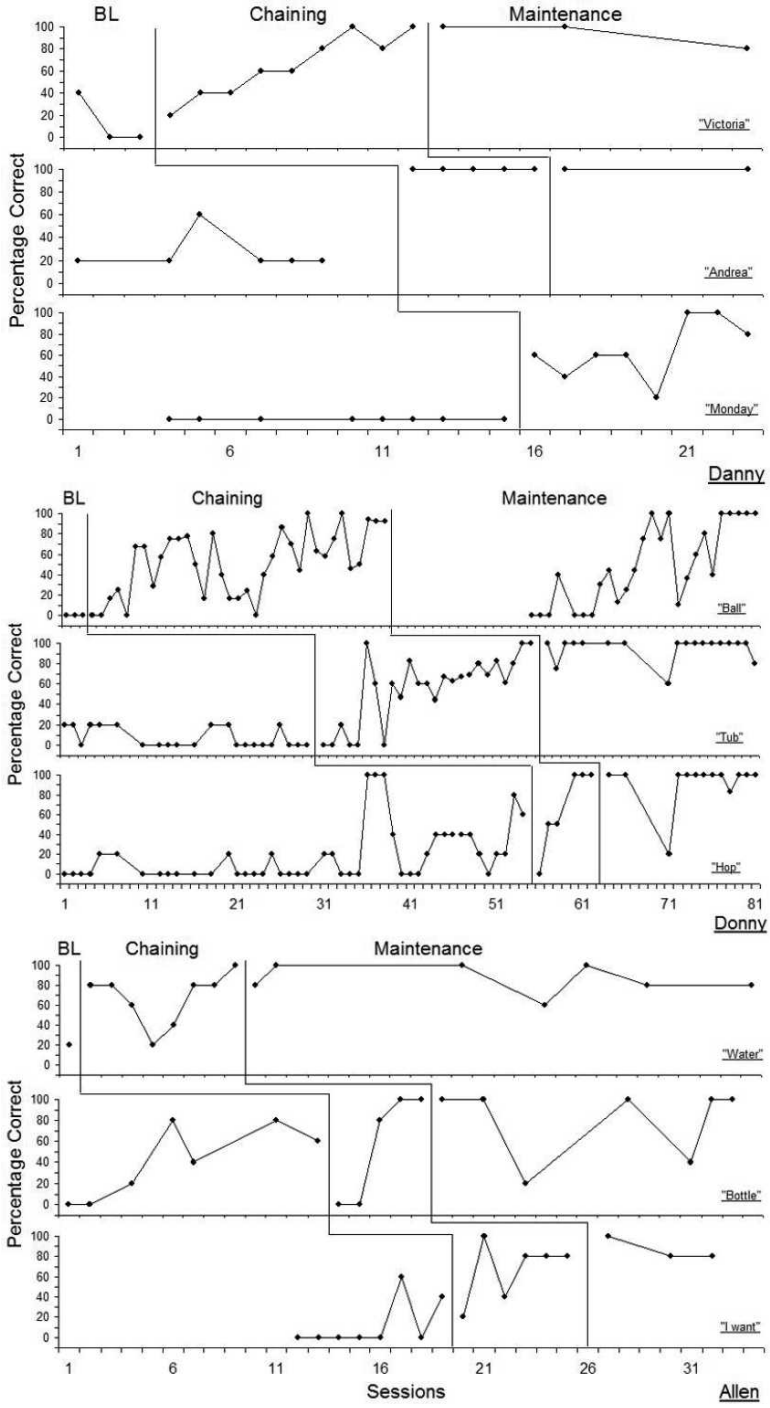

Figure 1. Percentage of correct responses across echoic behaviors for Danny (top three panels), Donny (middle three panels), and Allen (bottom three panels).

treatment, by participants' behavioral therapists, in the participants' homes. The therapists who implemented the procedures were bachelors-level clinicians, with no specialized training in research implementation. No difficulties were encountered in this context, so it is likely that the procedure will be feasible for other practitioners to implement during clinical services provided in community settings.

One point worthy of discussion is the improvement in correct responding observed during baseline with "hop" for Donny and "bottle" and "I want" for Allen. It is possible that these data revealed an extraneous source of influence on echoic responding (e.g., mere exposure during baseline), thereby threatening the internal validity of the study. However, the replication of the treatment effect across six other behaviors provides sufficient evidence that the intervention contributed to the observed improvement in echoic performance. Another possible interpretation is that response generalization occurred; that is, that the chaining procedure implemented on earlier behaviors resulted in improvements in untargeted echoics. This interpretation is supported by Young et al.'s (1994) findings, in which reinforcement produced generalization across echoics. Future researchers should use experimental designs in which response generalization does not threaten experimental control, such as a multiple baseline across participants. Furthermore, it is possible that after training multiple exemplars of complex echoics, a generalized ability to echo complex stimuli will emerge, thereby making it unnecessary to teach every individual complex echoic behavior in the future. Future research should experimentally evaluate this possibility by attempting to determine how many exemplars must be taught before response generalization emerges, if ever.

One potential limitation to the current study is that intervention ceased at short utterances. For example, it is not clear from the current data whether the procedure would allow clinicians to teach children to continue to combine words into more complex utterances, such as sentences. Future research should evaluate this possibility.

A final point warranting discussion is the conceptual question of whether the procedure studied here actually constitutes chaining. In each sequence of three trials for a particular target, the first trial prompted the first behavior in a sequence and the second trial prompted the second behavior in that same sequence, and this sequence resembles a chain with two links. However, reinforcers were delivered after each response, which is not usually done in chaining. In addition, the third trial modeled the entire chain, which is also not typically done. Perhaps the procedure would better be considered to be modified chaining or a chaining-like procedure.

In conclusion, the current study provides evidence that chaining can be used effectively to increase the complexity of echoics in children with autism. Relatively rapid treatment effects were observed, maintenance was observed in most cases, and all procedures were implemented as a part of the participants' regular clinical services. Future research should attempt to examine the effects of chaining echoics on generalization across complex echoic behaviors.

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